Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

SHOUT
SHARE
IT

UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1182

Washington, D. C. ▼ December 12, 1923

LIBRARY RECEIVED Jan. 8 1924 U. S. Department of Agriculture

THE IMPORTED PINE SAWFLY.[1]

By WILLIAM MIDDLETON,
Scientific Assistant, Forest Insect Investigations.

CONTENTS.

	Page.		Page.
Introduction	1	Parasites	16
Descriptions	1	Hosts	17
Life history and seasonal history	7	Distribution in the United States	20
Effect of meteorological conditions	14	Economic importance	20
Parthenogenesis	15	Control	21

INTRODUCTION.

A European insect, the imported pine sawfly,[2] has recently been found defoliating young pine trees in nurseries and on estates in certain of the New England and North Atlantic States.

This bulletin contains descriptions of the principal stages of the species and some information on its life history, host plants, distribution, and importance, together with a brief discussion of its control. The data presented are based on investigations of the sawfly conducted at the eastern field station of the Forest Insect Investigations, Bureau of Entomology, at East Falls Church, Va. The studies began with the receipt of material in August, 1915, and continued until the spring of 1919, when the last adults emerged in the cages.

Inasmuch as the species was an introduced and dangerous one which had not become well established in this country, great care was exercised in the cage work, in order to prevent its escape. A special double-walled, screen-wire insectary was constructed to which entrance was had only through a vestibule, and all the experiments were performed on young trees transplanted into this inclosure.

DESCRIPTIONS.

The following descriptions have been prepared, so that this species can be recognized in its principal stages. Those of the adult are by S. A. Rohwer.

[1] This bulletin was prepared under the direction of S. A. Rohwer, to whom the author is indebted for many helpful suggestions in conducting the investigations. The descriptions of the adult insects are by Mr. Rohwer. The majority of the material from which these studies were made was obtained from Dr. W. E. Britton, State entomologist of Connecticut.

[2] *Diprion simile* Hartig, order Hymenoptera; suborder Chalastogastra; superfamily Tenthredinoidea; family Tenthredinidae; subfamily Diprioninae.

53373—23—Bull. 1182——1

ADULT.

This species is the only North American representative of the genus Diprion and may be readily distinguished from the other Nearctic species belonging to the subfamily Diprioninae by the large and densely punctured metascutellum. The specimens which have been examined show very little variation, and all seem to represent the typical form of the species.

Female (Fig. 1, *a*).—Length 7 to 9 millimeters. Clypeus truncate; head with large, rather close punctures; postocellar area convex and more than twice as wide as long; postocellar furrow well defined; antenna distinctly tapering, the joints much broader than long and with very short rami (apical joints practically without rami), third joint distinctly longer than the fourth; scutum shining, with large, distinct punctures; scutellum and metascutellum opaque and with the punctures closer; tibial spurs simple; pad-like part of sheath elliptical in outline and close to the median line; apical sternite deeply angulately emarginate medially, lancet with nine rows of regular teeth. Black with yellow markings; head black except yellow clypeus, supraclypeal area, and scape; thorax yellow with the following parts black: Sternum, mesepimeron, large spots on prescutum and scutum, lateral part of scutellar area, and metascutellum; abdomen yellow with tergites 3 to 6 inclusive and median spots on following two black; legs, except the somewhat dusky femora, yellow; wings hyaline, venation pale brown with stigma somewhat darker and the costa somewhat paler.

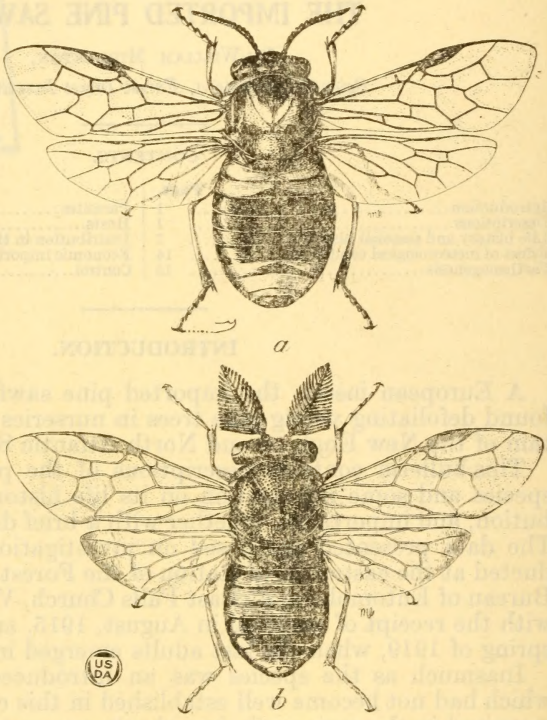

FIG. 1.—*Diprion simile: a*, Female; *b*, male.

Male (Fig. 1, *b*).—Length 5 to 7 millimeters. Agreeing with female in general structure; antenna long, the basal rami slightly less than half as long as half the flagellum; hypandrium distinctly punctured, broadly rounded posteriorly; head and thorax more coarsely punctured than in the female; valves of penis, when seen from the side, broad and the ventral margin armed with small, widely separated teeth. Black; venter of abdomen and legs beyond trochanters dark rufous; wings hyaline, venation pale brown, costa paler.

EGG AND EGG SLIT.

The eggs of the imported pine sawfly are about 1.5 millimeters long, with straight sides and bluntly rounded ends. They are oval in cross section, being 0.5 millimeter on the greater transverse diameter and 0.25 millimeter on the lesser transverse diameter. When first laid the eggs are pale whitish blue, translucent, shining, much like gelatin, and somewhat smaller than the above dimensions. After several days, development becomes marked by swelling and the color appears bluish green. When about to hatch they are quite swollen, sometimes as long as 1.75 millimeters, and are dark green. (Fig. 2, *b*.)

The eggs are laid in slits in the needles (Fig. 2, *a*). Adults emerging early lay in last year's needles, but those emerging when the present year's needles are of sufficient size appear to prefer these. The number of eggs deposited in a single needle varies. In the needles observed, from 2 to 16 eggs were laid, with an average of 8. Where more than one egg is laid the egg pockets adjoin one another, with merely a wall between. The pocket or slit is cut into the convex portion of the needle from an edge at an angle and the tissue composing the walls of the slit is of two textures (Fig. 2, *c*). The basal portions of these walls are the rather tough outer coating of the needle and the apical portions are delicate membranes, apparently made of torn needle pulp, which are pressed together following the laying of the egg, seal it in place, and somewhat conceal it. As the egg increases in size, it parts these lips and becomes exposed. When freshly made the cuts are yellowish green and the needle dark green, but as the eggs mature the cuts become somewhat brownish and the needles yellowish.

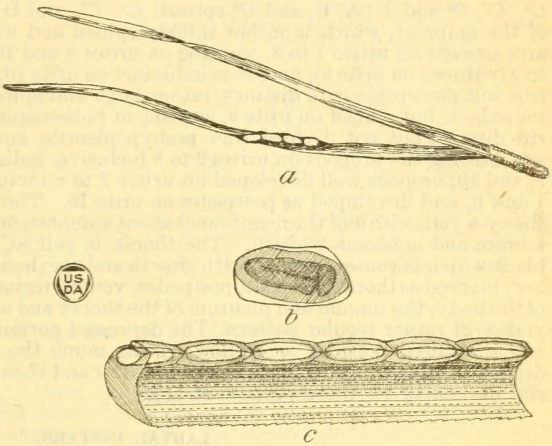

FIG. 2.—*Diprion simile: a*, Eggs in position in needle; *b*, egg, showing embryo; *c*, needle, showing eggs in pockets.

LARVA.

The following description [3] was made from a full-grown, sixth-instar larva of *Diprion simile* which had been preserved in alcohol. (Fig. 3.)

Length 20 millimeters; maximum breadth, across the metathorax, 4.5 millimeters. The head is circular in outline viewed from in front and the front plane slightly convex viewed from the side; frons and epicranium with a few fine hairs; epistoma with 4 hairs; labrum with 4 hairs; eye disks not elevated, eyes large, lenses convex; antennæ between and slightly closer to pleurostomata than eyes, composed of cone and two disks or partial ring joints; maxillæ with cardo, stipes, palpifer and 4-jointed palpi, galea, and lacinia; lacinia not flattened, rather triangular in outline viewed from apex, armed with large hornlike process or seta on the side toward labium and with rather large setæ forming an apical transverse row on the side of the lacinia parallel with the interior surface of the trophi; labium with palpiger and 2-jointed palpi. Thorax with the tergum composed of areas A, B, C, and D; A excepting in the prothorax, B,

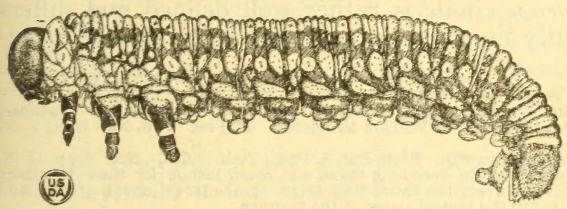

FIG. 3.—*Diprion simile:* Full-grown larva.

[3] The terminology used in describing the larva is that used by the writer in the descriptions of *Neodiprion lecontei* (Fitch) (Jour. Agr. Research, v. 20, no. 10, p. 741-760, 1921), with the changes adopted in "Some suggested homologies between larvæ and adults in sawflies" (Proc. Ent. Soc. Wash., v. 28, no. 8, p. 173-192, 1921).

and C with a few setæ or spines; A of the prothorax bare and constricted and D bare; alar area wanting or incorporated in the spiracular area of the prothorax, large in the mesothorax and metathorax; in the pleurum, preepipleurite large, well defined, and possessing setæ or spines; postepipleurite large, well defined, spined in prothorax but bare in mesothorax and metathorax; prehypopleurite large, triangular, of heavy chitin and sparsely, finely haired; posthypopleurite large with a prominent spined lobe; legs with 4 joints and an apical claw, joint 3 with small soft pad on inner side at apex. Abdomen with the tergum of urites 1 to 9 inclusive composed of areas A, B, C^1, C^2, C^3 and D; A, B, and C^2 spined, C^1, C^3, and D bare; urite 10 consists tergally of the epiproct, which is rather thickly spined and without pseudocerci; spiracular area present on urites 1 to 8, wanting on urites 9 and 10; alar area present on urites 1 to 9 (reduced on urite 9), absent or indistinct on urite 10; the pleurum with preepipleurite and postepipleurite distinct, rather large and spined on urites 1 to 8, reduced, indistinct, but spined on urite 9, wanting or indistinguishable on urite 10; hypopleurite distinct but not divided into prehypopleurite and posthypopleurite, unspined and bearing the uropods on urites 2 to 8 inclusive, indistinct or wanting on urites 1, 9, and 10; uropods well developed on urites 2 to 8 inclusive, not developed on urites 1 and 9, and developed as postpedes on urite 10. The head is black and shiny, with the eyes yellowish and the membranes about antennæ, mandibles, trophi, and between labrum and epistoma whitish. The thorax is yellow, much darkened with velvety black which becomes greenish with growth and age; legs black. The abdomen is yellow, marked as thorax; uropods, postpedes, ventral region, and anus undarkened. Most of the body, the tergum and pleurum of the thorax and abdomen is a mottled black and yellow of rather regular pattern. The depressed portions of the body wall are black and the raised portions are yellow, giving much the appearance of a yellow larva dipped in some adhesive black coloring matter and then allowed to wear off the material darkening its more prominent areas.

LARVAL INSTARS.

In the study of *Diprion simile* the experiments on the larvæ offered an excellent opportunity to determine the number of larval instars and the size of the larvæ during each instar. For convenience, this information is arranged in tabular form below. It will be noted that the species has six feeding instars in larvæ producing female adults and five feeding instars in larvæ producing males. This feature was remarked upon by the writer in treating *Cladius isomerus* Norton in a recent paper on the subfamily Cladiinae [4] and is probably common to sawflies, since H. C. Severin [5] records a similar difference in the number of instars between larvæ producing male and female adults in his account of *Neurotoma inconspicua* Norton.

The prepupa of *Diprion simile* is rather well defined and differs from the larva sufficiently in general appearance to be readily recognized.

---

[4] Rohwer, S. A., and Middleton, William. North American sawflies of the subfamily Cladiinae. With notes on habits and descriptions of larvæ by William Middleton. *In* Proc. U. S. Nat. Mus., v. 60, art. 1 (no. 2396), 1922. *See* p. 19.

[5] Severin, H. C. The plum webspinning sawfly. State Ent. S. Dak., Tech. Bul. 1. 1920. *See* p. 11, 26, tables 2, 3. Severin finds six instars for larvæ becoming males and seven instars for those becoming females. This larval period, however, covers the entire time spent by the larvæ above ground and therefore includes the stage recognized in the present paper as the prepupa.

TABLE. 1.—*Average size of larval instars and prepupa of Diprion simile, in millimeters.*

Instar or stage.	Head.		Body length.		Number of larvæ used to obtain averages.[1]
	Height.	Width.	Young.	Full grown.	
	Millimeters.	*Millimeters.*	*Millimeters.*	*Millimeters.*	*Millimeters.*
I	0.75	0.50	2.75	6.0	11
II	.95	.75	4.00	8.0	11
III	1.20	1.00	7.00	12.0	8
IV	1.60	1.40	8.00	15.0	7
V (male penultimate)	2.00	1.80	14.00	20.0	5
VI (male prepupa)	2.00	1.80	[2] 14.00	[3] 13.0	2
V (female antepenultimate)	1.95	1.65	11.00	18.0	3
VI (female penultimate)	2.20	2.00	15.00	25.5	3
VII (female prepupa)	2.20	2.00	[2] 19.00	[3] 12.0	2

[1] These larvæ were reared in isolation and measurements were made at frequent intervals. The dimensions obtained from them are perhaps few in number but accurate and from an instar or stage positively known. The averages obtained from these larvæ were found to apply to larvæ in the general rearing cages.
[2] Largest. Prepupæ do not feed and grow. They contract with development and the spinning of the cocoon.
[3] Smallest.

The different instars of the larvæ of *Diprion simile* are colored as follows:

INSTAR I.—Before feeding: Head whitish, eye spots blackish. Body dull gray. After feeding: Head and legs become blackish.

INSTAR II.—Much the same as the first instar. The dorsum darkens somewhat at the approach of the time to shed.

INSTAR III.—Head black. Body green to bluish gray. The day before molting to the fourth instar the larva begins to show dark dorsal, supraalar, and epipleural lines. This change previous to shedding is doubtless caused by the darker coloration of the approaching instar showing through the skin about to be shed.

INSTAR IV.—Head black. Body considerably darkened, greenish black and yellow, pattern of mottling similar to that of full-grown larva. The larva pales somewhat with age or increased size.

INSTAR V.—Head black. Body velvety black and yellow. The black becomes greenish with age or increased size.

INSTAR VI.—Head black. Body velvety black and yellow.

Each instar seems to have two poorly marked phases; first, a rapid growing period, usually covering the greater part of the instar, during which the body increases in length; and, second, a preparatory period preceding molting during which there is a retardation in growth or even occasionally a contraction. The accompanying diagram (Fig. 4) shows the records of growth of a male and a female larva in body lengths, instars and days, and illustrates this feature.

PREPUPA.

The prepupa of the imported pine sawfly does not feed and its development is accompanied by contraction rather than increase in size. The cocoon is spun in this stage and, protected within, the prepupa changes gradually as it develops into the pupa.

The following description is from a prepupa preserved in alcohol which had not begun the spinning of its cocoon. Prepupæ after spinning do not differ structurally from those which have not spun but are considerably more contracted. A prepupa that is to produce a female adult will measure about 19 millimeters in length before spinning its cocoon, while, after spinning, it will be about 12 millimeters long.

The size of the prepupa is discussed under "Larval instars."

The prepupa of *Diprion simile* is similar to the larva, in structure, with the armature of spines reduced to indistinctness. The head is grayish white, eye disks and apices of mandibles, only, black. The thorax and abdomen are both pale greenish white, with narrow green, dorsal longitudinal stripes and broader green supraalar to alar longitudinal lines which are broken by yellowish spots on B, C^1, C^2, the pale spiracular area, and the yellowish alar area. Pleurum pale but for a pair of greenish pleural spots. Venter, uropods, postpedes, anus, and epiproct pale, the latter faintly grayish.

COCOON.

The cocoons (Fig. 5) of *Diprion simile* are cylindrical, with hemispherical ends. They are single-walled, of fine texture, rather glossy, fairly stiff, but thin. Cocoons from which males emerge are somewhat smaller than those from which females issue, 7 by 3.5 millimeters being the size of the former, while the latter are 9.3 by 4 millimeters. The cocoons are usually dark brown; sometimes they are pale tan when made but become dark brown within a week or 10 days, and in one instance a whitish cocoon was spun which failed to become colored.

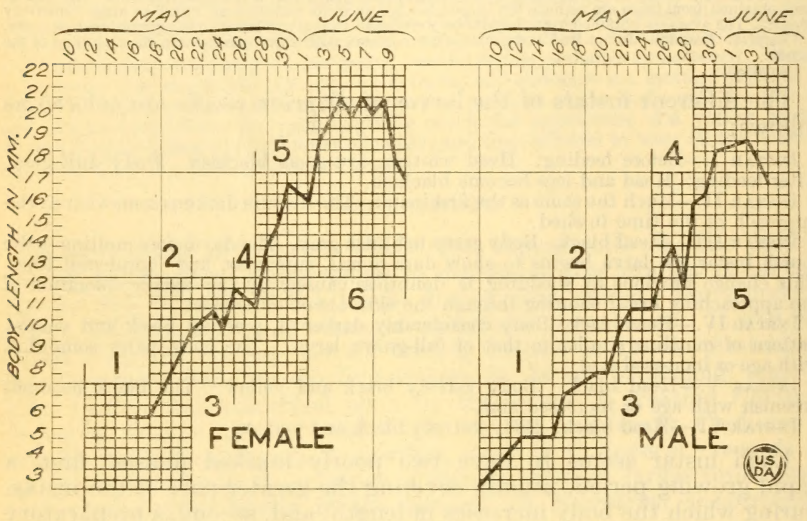

FIG. 4.—*Diprion simile:* Larval growth charts. Stage of larva indicated by large figures. Female has six stages, male five. Growth records are shown for a single female and a single male larva.

In captivity the cocoons were often spun on the needles, and while this may be the rule in nature the writer is inclined to believe that many of the prepupæ of this species, like those of *Neodiprion lecontei*, will make their cocoons in the ground for the sake of the protection thus afforded in winter. This view is supported by a European observation [6] which records the summer brood cocooning on the branches of the tree while the winter brood makes its cocoons beneath the tree.

The cocoon is spun of a "silken" thread from the vicinity of the mouth.[7] The end of the cocoon inclosing the caudal extremities of the prepupa is made first, then the anterior end is inclosed by a sidewise motion of the head. After the entire cocoon is formed the prepupa works over the inside, plastering a sticky substance to it. This coating makes the glossy inner surface.

[6] Britton, W. E. A destructive pine sawfly introduced from Europe. *In* Jour. Econ. Ent., v. 8, no. 3, p. 379–382. 1915. *See* p. 381.

[7] This thread doubtless comes from the apex of the labium, where the writer has observed a similar substance protruding in some prepupæ of *Cimbex americana* Leach in his possession.

LIFE HISTORY AND SEASONAL HISTORY.

The experiments to obtain data on the life history and seasonal history of *Diprion simile* were distinct from those pertaining to the choice of host plant and also from those pertaining to the ability of the insect to reproduce parthenogenetically. *Pinus sylvestris* was chosen as a host for this work because it seemed to be favored by the sawfly and because it had been shown to be a successful host in this locality by previous tests. In no instance was copulation observed, but opportunity for fertilization was provided by keeping constantly with each female at least two males in excellent condition. These experiments were made with small cylinder cages of screen wire on a steel frame, 14 inches in diameter by 24 inches high, the top of which was removable to permit easy access to the interior for observation or handling the material. These cages were placed over young trees of *Pinus sylvestris*, and adults of *Diprion simile* were then liberated within. There were also certain special life-history and seasonal-history studies, particularly some in which observations were made on larvæ of this sawfly reared in isolation to determine the number and duration of the instars and the influence of the sex of the individual upon this phase of development.

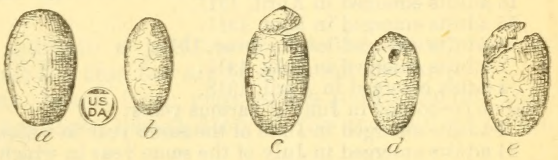

FIG. 5.—*Diprion simile:* Cocoons. *a*, Occupied by female, unopened; *b*, occupied by male, unopened; *c*, after emergence of female; *d*, male cocoon, showing emergence hole of a chalcid parasite; *e*, female cocoon, showing emergence hole of a dipterous parasite.

The data presented in the following account of *Diprion simile* show some singular likenesses and contrasts with the life of the related *Neodiprion lecontei*.[8] It would be well to emphasize that the imported pine sawfly has the same apparent division of the emergence period into Broods A and B. It differs somewhat from Leconte's sawfly in the course of its issuance, a fact which may be explained either as inherent in the species or as caused by change of environment. The climate and other natural factors in the United States may be so different from those to which it is accustomed that it is unstabilized here. Should this prove true, the situation with regard to *Diprion simile* may become very different within a few years, and the insect may even become a more serious problem than it now promises to be. The imported pine sawfly has important life-history and seasonal-history advantages, and if it can become a recognized depredator while unstabilized by the conditions of this new environment, the destructive possibilities of the species when it is properly adjusted will be necessarily greater. In that case it may possibly present a new life history and seasonal history.

ADULT EMERGENCE.

The emergence of adults from the cocoons of a single colony of the larvæ of *Diprion simile* occurs over a considerable period, approximating a year. This emergence is not continuous, but divides itself

[8] Middleton, William. Leconte's sawfly, an enemy of young pines. *In* Jour. Agr. Research, v. 20, no. 10, p. 741-760. 1921.

into a period early in the year and a period late in the year. The adults are separated into Brood A, those issuing in the first emergence period following cocooning, and Brood B, those issuing in the second emergence period following cocooning.

The early emergence period occurs from April to June and is not distinctly separated from the later emergence period, which occurs during July and August. The rearing cages, however, show a marked decrease in the number of adults coming from cocoons during June.

The following summary of records of the issuance of adults shows the duration of this period and its tendency to divide into two parts, the months of maximum emergence being April, May, and July.

Larvæ and pupæ collected in August, 1915:
1 adult emerged in August, 1915.
77 adults emerged in May, 1916.
5 adults emerged in June, 1916.
1 adult emerged in July, 1916.
Cocoons collected in April, 1917:
16 adults emerged in April, 1917.
95 adults emerged in May, 1917.
2 adults emerged late in June, 1917.
2 adults emerged in July, 1917.
1 adult emerged in April, 1918.
Larvæ cocooning in June of various years:
2 adults emerged in June of the same year in which they cocooned.
24 adults emerged in July of the same year in which they cocooned.
1 adult emerged in August of the same year in which it cocooned.
7 adults emerged in April of the year following that in which they cocooned.
8 adults emerged in May of the year following that in which they cocooned.

LONGEVITY OF ADULTS.

The average length of life for adults of *Diprion simile* was 6.6 days, with a range from 3 to 11 days. The life of the female was slightly longer than that of the male, the former averaging 7.5 days, with a range from 5.5 to 11 days, while the latter averaged 5.8 days, with a range from 3 to 9 days. The life of female adults known to have laid eggs was somewhat longer than the life of those not known to have laid eggs. Females laying eggs averaged 7.75 days, those not known either to have laid eggs or not to have laid eggs averaged 7.66 days, while those known not to have laid eggs averaged 7 days. The two shortest-lived males were the progeny of parthenogenetic females. Only two of these were available for this study, and these lived, one 3 and the other 4 days.

PROPORTION OF SEXES.

The males seem somewhat to exceed the females in number, and from a series of 227 adults issuing from cocoons in certain of the cages, 134, or 59 per cent, were males, while 93, or approximately 41 per cent, were females.

MATING.

Mating was not observed. At different times three males were caged in glass vials with a single unfertilized female without their paying her the slightest attention. This, however, was probably due to the close confinement of the sawflies under observation, which tended to distract them and prevent or discourage natural behavior. The fact that from the life-history and seasonal-history

experiments both sexes were obtained in the progeny, while, as will be stated farther on, in parthenogenetic experiments only male adults were obtained, indicates that mating is a regular occurrence.

OVIPOSITION.

The eggs are laid in the needles of the pine and the adults emerging from their cocoons early in the year oviposit in the old or last year's needles, while the adults emerging later in the year lay their eggs in the needles of the current year. The following note, made in observations on the habits and activities of the adults in the life-history and seasonal-history cages, shows the increase in attractiveness of the current year's needles.

All the females, except the one emerging at the latest date, i. e., June 23, 1916, laid their eggs in the old or grown needles, but this female, possibly because of the advance of the younger needles, delayed her oviposition several days and then apparently first attempted egg laying in these new leaves. After two slits or thrusts, possibly having succeeded in laying an egg in one of these, she began on the old needles and finished her work on them.

This note seems to indicate a preference for the young needles which were still too small for this female to oviposit in them.

The following account, taken from cage notes made during these experiments, gives an accurate description of the method of oviposition:

The female begins laying eggs near the base of the needle and works toward the tip, making a new incision for each egg. In oviposition the mandibles usually close upon the needle; the antennæ extend forward and are usually quiet and the wings are folded, at rest on the back. The ovipositor (Fig. 6, *b*, *c*) is exserted from between the right and left halves of the sheath, forming an angle of about 60° with the needle. It is worked into the needle and straightened until as it disappears it forms a right angle with the needle, saw edge forward (Fig. 6, *a*).

The posterior margin of the seventh sternite is membranous and is produced medianly to form a sort of trough (*tr*) for conveying the eggs into the slit prepared for them. The sides of the trough are supported by a pair of diverging chitinous pieces or more rigid areas. This trough during oviposition is immediately in front of the slit that is being cut and serves as a support to the abdomen, maintaining a constant distance between body and needle and contributing to a rigidity and firmness of the base of the working parts in their relation to the needle. Posterior to the trough and basad of the sheath proper there is a pair of rather small rectangular plates or trowels (*t*) (Fig. 6, *d*), one plate at each side, attached to the base of the basal portion of the sheath (sh^1) and appearing similarly attached to the base of the lance (*le*). These plates were observed for the first time in this insect and are not found in *Neodiprion lecontei*, which belongs to the same subfamily, nor has the writer been able to discover similar developments in sawflies outside of the Diprioninae. The function of these plates or trowels is apparently to support and mold the torn needle fiber into walls and cover for the egg pocket. The sheath (sh^1 and sh^2) is posterior to these plates (*t*) and its right and left halves cover respectively the right and left sides of the needle at the point of incision. During the sawing there are alternate contractions and expansions of the pleurum of the ninth urite which cause the sheath to flex or bend at the juncture of the basal (sh^1) and apical (sh^2) portions, and a side-to-side oblique movement of the trough (*tr*). The saw is worked or dragged until the trough (*tr*) reaches the mesothoracic legs. The puncture is then complete and the abdomen is slightly elevated. The trough (*tr*) and the trowels (*t*) are now pushed back together, smoothing off the torn fiber at the mouth of the pocket and bringing together the walls of the cavity at its opening. The saw is withdrawn at the same time. It is not visible except through the needle tissue, being hidden by the trowel (*t*), and its withdrawal is accomplished or accompanied by a backward, upward folding movement. The entire egg-laying process consumes about two minutes.

Oviposition occurs over several days, the female going from needle to needle. Table 2 indicates the number of eggs laid and gives an idea of the number of needles upon a tree that are attacked.

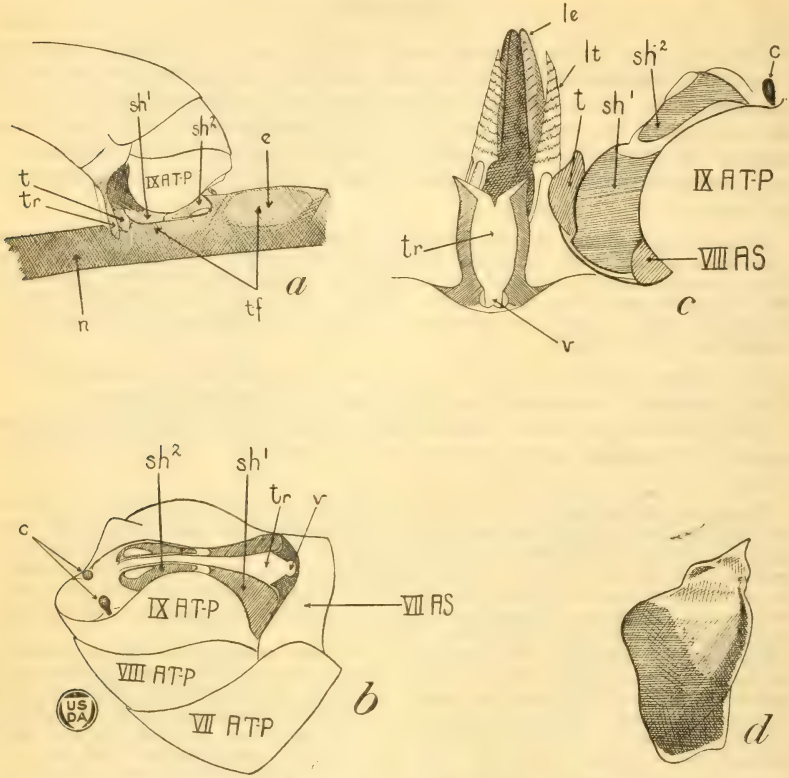

FIG. 6.—*Diprion simile:* Ovipositor. *a*, Apex of abdomen of female adult in position over nearly completed egg slit (enlarged); *b*, three-quarters ventral view of apex of abdomen of female adult (enlarged); *c*, ventral view of portion of egg-laying apparatus of female adult (much enlarged); *d*, side view of trowel, from ovipositor of adult female (greatly enlarged).

TABLE 2.—*Oviposition records of Diprion simile.*

No.	Number of needles oviposited in and number of eggs in each.										Total number of eggs.	Host plant.
	1	2	3	4	5	6	7	8	9	10		
1	9	0	3	9	5	.....	.....	.....	.....	.....	26	Pinus austriaca.
2	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	P. laricio.
3	11	16	11	6	9	.....	.....	.....	.....	.....	53	P. sylvestris.
4	12	2	7	6	.....	.....	.....	.....	.....	.....	27	Do.
5	12	2	3	5	12	11	8	2	5	8	68	Do.
6	5	10	8	6	12	4	13	14	7	2	81	Do.

Of these experiments the first and second were failures owing to the host plant chosen, and the eggs in the third and fourth were laid by virgin females, and therefore will be treated farther on, in considering the experiments on parthenogenetic reproduction in this species.

Table 3 shows the length of time elapsing between the emergence of the adult and oviposition.

TABLE 3.—*Preoviposition period of adults of Diprion simile.*

No.	Date adult emerged.	Date oviposition began.	Time in days from emergence to oviposition.	Host plant.	Remarks.
1	May 8	May 9	1	Pinus sylvestris	
2	May 11	May 11	0	do	
3	May 12	May 16	4	Pinus austriaca	Host plant unfavorable.
4	May 8	May 10	2	Pinus sylvestris	Unfertilized female.
5	May 9	May 11	2	do	Do.
6	June 20	June 23	3	do	New needles attractive.

From the consideration of all the available data the writer is of the opinion that a fertilized female will begin laying eggs soon after fertilization, provided material suitable for oviposition can be found. Such was the case with the first and second females in Table 3. Unfertilized females will begin laying after a two-day period during which they await mating, provided that suitable material is convenient, as shown by the fourth and fifth females, which were used in experiments on parthenogenetic reproduction. A period of longer than two days presumably indicates an unfavorable host, unfavorable condition of host, or other disturbing factor. In the instance of female No. 3, the four-day delay is believed to indicate that *Pinus austriaca* is an unfavorable host, a conclusion borne out by other observations discussed under "Hosts." In the instance of female No. 6, the three-day delay is believed to have been caused by the advanced condition of the young needles, which, though not of sufficient size for successful oviposition, were yet large enough to attract her and thus lengthen the time between emergence and oviposition.

FERTILITY AND INCUBATION.

In only one of the experiments was an accurate record of the eggs from laying to hatching kept, and here it was found that 48 eggs out of 69, or 69.5 per cent, hatched. The period of time elapsing between oviposition and hatching is called the incubation period. Table 4 records the results of investigations to determine the length of this period.

TABLE 4.—*Incubation period of Diprion simile.*

Date laid.	Date hatched.	Length of period.[1]	Host.	Remarks.
		Days.		
May 9 to 15	May 22 to 26	11–13	Pinus sylvestris	
May 10	May 22	12	do	Unfertilized female.
May 11 to 15	May 25 to 29	14	do	Do.
Do	do	14	do	
May 16	May 29	13	Pinus austriaca	
June 23 to 24	July 1 to 2	8	Pinus sylvestris	

[1] In counting the number of days in the incubation period, it was assumed that the first eggs laid were the first to hatch and that the latest laid were the latest hatched.

For eggs laid about the middle of May (May 9 to 19), from 11 to 14 days were required for development to the point of hatching, averaging 12.8 days. For eggs laid in late June, 8 days sufficed for development. Fertilized and unfertilized eggs, apparently, did not differ in the duration of the incubation period.

LARVAL DEVELOPMENT.

The larvæ of the imported pine sawfly shed their skins as they develop. The periods between moltings of the larva are called instars. The number of instars, the difference in the number between larvæ producing female adults and those producing males, and the size and appearance of the larvæ in each of the various instars have been treated under "Larval instars."

Table 5 shows for a number of larvæ the time spent in each instar, the average length of the instar, and the total length of the larval or feeding period. This table is arranged to show sex and date of hatching of each individual or group of individuals, because the sex makes a difference in the number of instars, and the rate of development of the larvæ appears to be accelerated as the season advances.

TABLE 5.—*Number and length of larval instars of Diprion simile, showing individual's date of hatching and sex.*

Date egg hatched.	Sex.	Length of instar.						Total.
		Instar I.	Instar II.	Instar III.	Instar IV.	Instar V.	Instar VI.	
		Days.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*
May 8[1]	Male	6	5	3	6	12	.....	32
Do.[1]	do	6	5	4	5	11	.....	31
May 9[1]	do	7	5	4	4	9	.....	29
May 12[1]	do	6	4	4	4	11	.....	29
Do.[1]	do	6	4	4	4	10	.....	28
May 22[2]	do	7	4	4	6	2	.....	23
May 25[2]	do	6	5	5	4	6	.....	26
Do.[2]	do	4	7	7	5	3	.....	26
Extremes	do	4 to 7	4 to 7	3 to 7	4 to 6	2 to 12	.....	23 to 32
Average early	do	6	4⅞	4⅜	4¾	8	.....	28
July 1	do	4	5	2	3	2	.....	16
Average mid-year	do	4	5	2	3	2	.....	16
May 9	Female	9	4	5	3	6	10	37
May 12	do	6	4	4	2	5	9	30
Do	do	6	4	4	2	4	9	29
Extremes	do	6 to 9	4 to 4	4 to 5	2 to 3	4 to 6	9 to 10	29 to 37
Average early	do	7	4	4⅕	2⅖	5	9½	32

[1] Isolated for stages. [2] Cage work.

LARVAL HABITS.

The larvæ from the time of hatching to the latter part of the second instar or the beginning of the third feed only on the exterior of the needles, expecially from the angles or sides. They then begin to consume the entire needle. At about the fourth or fifth instar they attack the young shoots, feeding on them basally to an extent sufficient frequently to cause the shoots to die and fall. This habit of feeding on the shoots is not essential to the development of the

larvæ, since caged individuals supplied with needles complete their growth successfully and become adults; nor does it, among those larvæ practicing it, supplant needle eating.

PREPUPAL AND PUPAL PERIOD.

When the larvæ have finished feeding they evacuate their alimentary tracts and shed their skins, becoming prepupæ. They then crawl about until each finds a suitable place and spins its cocoon. The length of time spent in the prepupa stage varies considerably. When adults emerge the same year this stage may be as brief as 10 days, when they emerge the following year it may be as long as 341 days.

Table 6 records the results of some experiments to determine the length of the prepupal period and the time spent within the cocoon. The prepupal period as recorded in this table is not separated from the pupal period. It is difficult to determine the exact duration of the pupal period. It seems to be brief and the pupa is seldom obtained by cutting open cocoons, the insects being nearly always found in the prepupal or in the unemerged or immature adult stage.

TABLE 6.—*Dates of becoming prepupa, of cocooning, and of emergence.*

ADULTS EMERGING THE SAME YEAR IN WHICH THEY COCOON.

Individual No.	Host plant.	Date individual became prepupa.	Date cocooned.	Days between time insect became a prepupa and cocooned.	Date adult emerged.	Days in cocoon.	Days between time insect became prepupa and emerged as adult.
1	Pinus cembra	June 29, 1917	July 2, 1917	3	July 9, 1917	7	10
2	P. virginiana	.....	June 29, 1917	.....	July 7, 1917	8	.....
3	P. strobus	.....	June 18, 1917	.....	June 27, 1917	9	.....
4	P. monticola	.....	June 29, 1917	.....	July 9, 1917	10	.....
5	P. divaricata	.....	do	.....	do	10	.....
6	P. sylvestris	.....	June 22, 1917	.....	July 5, 1917	13	.....
7	do	July 3, 1916	July 7, 1916	4	Aug. 1, 1916	25	29
	Average	.....	.....	3.5	.....	11.7	19.5

ADULTS EMERGING THE FOLLOWING YEAR.

8	P. flexilis	.....	July 9, 1917	.....	Apr. 15, 1918	280	.....
9	P. taeda	July 11, 1917	July 12, 1917	1	May 2, 1918	294	295
10	P. monticola	.....	June 29, 1917	.....	Apr. 24, 1918	299	.....
11	P. divaricata	.....	do	.....	May 5, 1918	310	.....
12	P. virginiana	.....	do	.....	May 6, 1918	311	.....
13	P. sylvestris	.....	June 22, 1917	.....	May 3, 1918	315	.....
14	do	June 15, 1918	June 17, 1918	2	May 22, 1919	339	341
	Average	.....	.....	1.5	.....	306.8	318

SUMMARY OF LIFE HISTORY AND SEASONAL HISTORY.

Variations in the length of the several stages of *Diprion simile*, due to known factors such as season, sex, etc., or to unknown factors such as what determines the prepupa to emerge the same or the next year, cause variations in the total length of the insect's life cycle. Table 7 indicates the various lengths of life and periods to be expected.

TABLE 7.—*Life chart (average) of Diprion simile.*

Period.	Progeny of adults issuing in the spring.				Progeny of adults issuing in summer.			
	Adults emerging same year as cocooning.		Adults emerging the next year after cocooning.		Adults emerging same year as cocooning.		Adults emerging next year after cocooning.	
	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.
	Days.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*
Incubation period	12.8	12.8	12.8	12.8	8	8	8	8
Larval period:								
First stage	6	7	6	7	4	.....	4	.....
Second stage	4⅞	4	4⅞	4	5	.....	5	.....
Third stage	4⅜	4½	4⅜	4½	2	.....	2	.....
Fourth stage	4¾	2⅓	4¾	2⅓	3	.....	3	.....
Fifth stage	8	5	8	5	2	.....	2	.....
Sixth stage	.....	9⅓	.....	9⅓	.....	.....	.....	.....
Total	28	32	28	32	16	[1] 18	16	[1] 18
Prepupa (including pupal period)	10	10	341	341	29	29	295	295
Adult period	5.8	7.5	5.8	7.5	5.8	7.5	5.8	7.5
Total	56.6	62.3	387.6	393.3	58.8	62.5	324.8	328.5

[1] Obtained by rule of proportion, as no isolation for length of larval stages gave female adults.

The accompanying chart (Fig. 7) gives a general view of the activities of this species covering a period of about four years, especially the relations existing between stages, broods, generations, and colony periods, and shows the possible opportunities of the species to inbreed and crossbreed among the various colonies, broods, and generations.

EFFECT OF METEOROLOGICAL CONDITIONS.

The notes on the effects of meteorological conditions on this species are incomplete and do not lead to any definite conclusions with regard to the part climate will play in its establishment or in the restriction of its range in America. The small number of adults obtained in the rearing experiments undertaken under the life-history, seasonal-history, and host-plant work gives the impression that the climate of the section of the country where this work was undertaken, East Falls Church, Va., near Washington, D. C., is rather unfavorable for *Diprion simile*, while the apparent establishment of the species in New England, New York, and New Jersey points to the suitability of a somewhat cooler climate.

In the cage work, where the rapidity of development was noted, it was observed to be accelerated by increased temperature.

Table 8 records the duration of stages and instars in days for two colonies of *Diprion simile* between which there was a difference of 46 days in the date of egg laying, and shows the average temperature during each of the stages or instars.

TABLE 8.—*Effect of time of year and temperature on rate of development of the egg and larval instars of Diprion simile.*

Stage.	Earlier colony.			Later colony.		
	Date stage or instar began.	Time in stage or instar.	Average temperature in stage or instar.	Date stage or instar began.	Time in stage or instar.	Average temperature in stage or instar.
	1916	*Days.*	° *F.*	1916	*Days.*	° *F.*
Egg	May 9	13	61.61	June 24	7	72.85
Larval instar:						
I	22	7	68.78	July 1	4	71.25
II	29	4	64.50	5	5	72.70
III	June 2	4	66.25	10	2	77.75
IV	6	6	64.33	12	3	79.00
V	12	5	67.90	15	2	75.25
VI	17	12	70.46	17	7	76.28
Prepupa	29	.....	.....	24	.....	.....
Total	.....	51	66.19	.....	30	74.51

Some scattered observations record the larvæ feeding close to the trunk on a cool and rainy day (temperature 60° F., humidity 87 per cent), feeding vigorously and spread out on a warmer and less humid day (temperature 69° F., and humidity 68 per cent), and clustered on needles close to the bole on a still warmer and drier day (temperature 85° F., humidity 40 per cent). These observations would seem to indicate a rather low optimum temperature, somewhere between 69° and 85° F., with a rather delicate responsiveness to any considerable variation in temperature, and the fact that the larvæ were observed to be rather slow in developing during a damp period and inactive during a cool, rainy spell (temperature 56° to 71° F. and humidity 85 per cent) tends to show a similar sensitiveness to humidity. The observations, however, are too few and were made in too restricted an area to be of much value.

PARTHENOGENESIS.

Diprion simile can reproduce parthenogenetically; that is, eggs laid by virgin females are fertile and hatch, producing larvæ which grow, become prepupæ, spin cocoons, and finally emerge as adults. All the adults thus far obtained from eggs of unfertilized females, however, are males, a result believed usual for parthenogenetic reproduction in sawflies.

Females that have not mated appear to wait two days before commencing oviposition, as shown in Table 3, but after this period passes they begin to lay unfertilized eggs. Two of the experiments performed to obtain these unfertilized eggs were successful, one female laying 53 eggs, the other 27. A comparison of the number of eggs laid parthenogenetically with the number laid by a normal fertilized female indicates that the virgin female lays only half as many eggs as the fertilized female. In the two parthenogenetic experiments in which eggs were deposited about 72½ per cent of the eggs hatched, which is approximately the same as the percentage of hatching obtained from eggs of fertilized females. The mortality among the

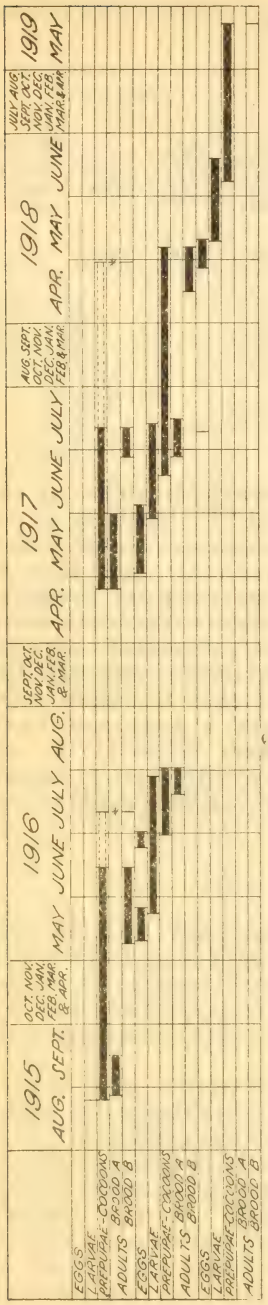

FIG. 7.—*Diprion simile*: Chart showing in a general way the life history and seasonal history data obtained in studies of two separate lots of *Diprion simile* material, one received in August, 1915, which was under observation during 1915 and 1916, and the other received in April, 1917, and used in experiments during 1917, 1918, and 1919. It shows the division of the adult emergence period into at least two broods, A and B. Two adults, one emerging from the cocoon in July, 1916, and the other in April, 1918, seem to have been somewhat retarded, and these are indicated by a superimposed asterisk.

larvæ, however, was higher in the progeny of virgin females, and few survived to become adults. It may be that larvæ wanting male parents are lacking in vitality and when developing to the adult produce an insect with less viability. This is indicated by the death of a great percentage of the larvæ under apparently favorable conditions and the shorter life of adults from eggs laid by unfertilized females.

PARASITES.

Only two species of natural enemies were obtained from the experiments performed at the eastern field station, East Falls Church, Va. These were *Dibrachys nigrocyaneus* Norton and a species of Eurytoma. Britton and Zappe[9] record the following: Hymenoptera: *Dibrachys nigrocyaneus* Norton, *Monodontomerus dentipes* Boheman, *Dibrachoides verditer* Norton, *Delomerista* n. sp., *Cerambycobius* sp. (probably new), *Eurytoma* sp., *Hemiteles utilis* Norton. Diptera: *Exorista petiolata* Coquillett.

All parasites specifically identified are native species, with the exception of *Monodontomerus dentipes* Boh., which is a European species already recorded from the United States.

Dibrachys nigrocyaneus was rather abundant, much more so than any of the other species, and Britton and Zappe state that only the first three species recorded in their list given above were reared in sufficient numbers to indicate that they are at all effective in holding the pest in check.

Table 9, from Britton and Zappe, gives the general results of an examination of cocoons collected during the winter of 1916–17.

A short experiment on the length of life of *Dibrachys nigrocyaneus* Norton was performed. From 65 adults caged without food all the males died within three days and all females

[9] Britton, W. E., and Zappe, M. P. The imported pine sawfly. *In* Conn. Agr. Exp. Sta. Bul. 203, p. 273–290, 1917. See p. 283.

within eight days; and from 40 adults supplied with cotton soaked in sugar water all the males died within three days, but all the females, except 1, were living on the thirteenth day, and all were not dead until the seventeenth.

TABLE 9.—*Cocoons of Diprion simile collected during the winter of 1916–17 and examined for parasites.*

Condition.	Number.	Per cent.
Adult sawflies had emerged	1,321	41
Parasites had emerged	1,210	37
Torn open and eaten	191	6
Dead	518	16
Total	3,240	100

Several experiments were made with *D. nigrocyaneus* Norton, with the object of observing oviposition and studying the relation of the parasite to this host. All resulted in failure, however, for no parasitism was obtained, although the chalcids endeavored to oviposit, usually more than once, in the cocoons supplied. Possibly *D. nigrocyaneus* does not attack *Diprion simile* in the cocoon stage.

The presence and activity of these parasites must not lead to the conclusion that they will bring about an effective natural control of *D. simile*. If the permanent establishment of this pest is to be prevented, or if its multiplication and work are to be checked, artificial control measures, such as those recommended, must be applied.

HOSTS.

If the imported pine sawfly is able to feed on a number of species of pine this will be an important factor in the establishment of the species in this country, and it is extremely desirable to know if it can and will use our native pines successfully. Restricted to introduced ornamental species of pines, *Diprion simile* would at worst only become a nursery and estate problem, but if it will attack our American pines it may become a serious forest problem. At present the sawfly seems to be confined to young pines of imported species and has only been recorded from nurseries and estates.

To determine the range of host plants which this insect can successfully utilize, two series of host-tree experiments were conducted. One was to determine the ability of *Diprion simile* to use a given host successfully from oviposition to the production of adults. The other was to determine the preferred host plants of the sawfly, if there are any. In the first series of experiments a number of adult males and females of *D. simile* were confined upon a particular species of young pine to observe its suitability. In the experiments on choice of host species a quantity of small native and introduced pines were transplanted into the large screen-wire insectary previously mentioned and a number of males and females liberated within the inclosure.

Table 10 gives the results of the experiment to determine the imported pine sawfly's choice of host plants. Fifty-four male adults and fifty-nine female adults of *D. simile* were liberated in the insectary,

into which the following species of young pines had been transplanted.

Species.	Number of trees placed in insectary.	Species.	Number of trees placed in insectary.
Pinus austriaca	2	Pinus ponderosa	5
Pinus cembra	2	Pinus resinosa	3
Pinus divaricata	2	Pinus strobus	5
Pinus flexilis	3	Pinus sylvestris	15
Pinus laricio	4	Pinus taeda	1
Pinus monticola	3	Pinus virginiana	3

Twelve species and a total of forty-eight trees.

In Table 10 the host trees are arranged according to the number of trees of each species that were chosen by the females for oviposition and the suitability of these pines as hosts is indicated by the number of individuals of the sawfly that were able to develop through the various stages from egg to adult.

Frequency of selection for oviposition has been considered a somewhat better guide to the appeal of the various pines to the sawfly than the numbers of the different stages of the insect obtained. This is especially true where the number of adults obtained exceeds a third of the total number of larvæ, since the larvæ after hatching were cage-reared, and, although protected from parasites, doubtless experienced a number of difficulties due to handling and to their artificial surroundings. The species of pines believed most favorable for *D. simile* are therefore placed at the beginning of the table.

TABLE 10.—*Experiment to determine the host-plant preference exhibited by Diprion simile.*

Species and serial number of host tree.	Number of trees of species chosen.	Eggs.	Larvæ.	Cocoons.	Adults.
Pinus sylvestris, trees 1, 20, and 29	3	[1] x	13	11	5
strobus, trees 5 and 6	2	x	36	[2] 9	7
cembra, tree 2	1	x	12	11	8
virginiana, tree 14	1	x	21	20	10
divaricata, tree 1	1	x	14	13	4
monticola, tree 2	1	x	10	6	3
flexilis, tree 2	1	x	5	2	1
taeda, tree 9	1	8	5	3	1
resinosa, trees 16 and 18	[3] ?	0	2	.....	.....
austriaca, tree 2	[3] ?	0	1	.....	.....

[1] x=number not counted.
[2] 27 larvæ killed—rain.
[3] ?=trees examined and no eggs found. Therefore, while it is possible that eggs may have been overlooked, it is also possible that a larva dropping or knocked from another tree may have reached these; consequently these species can not be given full credit for choice.

Table 11 gives a summary of experiments in which adults of *Diprion simile* were confined in cages on single young trees of certain species of pine. It shows in some degree the greater success attending the use of *Pinus sylvestris* as a host for the sawfly.

TABLE 11.—*Experiments showing the results accompanying the forced use of certain species of pine as hosts by Diprion simile.*

Species and serial number of host tree.	Parent females.	Eggs.	Larvæ.	Cocoons.	Adults.
Pinus sylvestris:					
Tree 1	1				
Tree 2	1	9	3	2	
Trees 4 and 5	1	[1] N 9	21		
Trees 6 and 3	1	79	48	9	
Trees 15 and 16	1	53	43		
Trees 17 and 2	1	27	18	2	2
Trees 18 and 19	1	68	[2] x	3	1
Tree 20	1				
Tree 21	1	9	3	2	1
Tree 29	1				
Tree 30	2	6	5	4	
Pinus virginiana, tree 10	3				
Pinus austriaca:					
Tree 1	1				
Tree 2	1	26	5		
Pinus cembra, tree 1	1				
Pinus divaricata, tree 36	2				
Pinus flexilis, tree 1	1				
Pinus laricio, tree 1	3	9			
Pinus strobus:					
Tree 16	2	13	2		
Tree 17	1	29	6		

[1] N=needles in which eggs have been deposited but the number of eggs not counted.
[2] x=number not counted.

Britton and Zappe,[10] in their paper on this species, give the following list, in which the pines are arranged "according to the preference shown by the sawflies in nature and to the largest number of sawflies reaching maturity" in their host-plant experiments:

Pinus excelsa Wall. Bhotan pine
Pinus cembra Linn. Stone pine
Pinus flexilis James. Limber pine
Pinus strobus Linn. White pine
Pinus koraiensis Sieb. & Zucc. Korean pine
} Five-needled pines.

Pinus montana Du Roi. Mugho pine
Pinus densiflora Sieb. & Zucc. Japanese red pine.
Pinus resinosa Ait. Red pine.
Pinus sylvestris Linn. Scotch pine
Pinus ponderosa Dougl. Bull pine
Pinus laricio Poir. var. *austriaca* Endl. Austrian pine
} Two-needled pines.

Pinus rigida Mill. Pitch pine. Three-needled pine.

This list shows that *Diprion simile* has a decided preference for the five-needled and the softer two-needled pines. A comparison of this list with the writer's experiments shows an agreement as to the preference for the five-needled pines and the apparent lack of suitability and attraction possessed by *P. laricio*, *P. austriaca*, and *P. ponderosa*, but a disagreement regarding *P. sylvestris*, which was a favored tree and capable of carrying the species from egg to adult in the writer's cages, while, along with *P. ponderosa* and *P. laricio* variety *austriaca*, it was almost immune to infestation in the experiments of Britton and Zappe.

From these data it seems reasonable to suppose that *Diprion simile* is capable of utilizing several of our American pines as hosts and therefore may succeed in establishing itself in the forests of the United

[10] Britton, W. E., and Zappe, M. P. *Op. cit.*, p. 278.

States. Furthermore, the species of pines represented above are from sufficiently different sections of the country to make available a possible host in most of our pine-growing regions and in such a variety of climates that some of them must be favorable for the insect's development.

DISTRIBUTION IN THE UNITED STATES.

FIG. 8.—*Diprion simile*: Distribution in the United States. A round black spot indicates a report from a definite locality; a square spot indicates occurrence in the State, but without definite locality.

Diprion simile is known to occur in nurseries in Connecticut, New York, Pennsylvania, and New Jersey. Specimens have been received from Massachusetts, and the species is recorded from Indiana.[11]

The history of the sawfly in the United States suggests that it was introduced with imported nursery stock, a view which is supported by the fact that in Connecticut, New Jersey, and Massachusetts it has been intercepted at quarantine inspection ports.

The following list gives the localities from which the species is recorded (see also Fig. 8):

Connecticut: Derby, Greenwich, Hartford, New Canaan, and New Haven.[11]
Indiana.
Massachusetts.
New Jersey: Elizabeth, Rutherford, and South Orange.[12]
New York: Flushing, L. I.
Pennsylvania: Chestnut Hill [13] and Penbrook.[13]

ECONOMIC IMPORTANCE.

The imported pine sawfly is to be regarded as an extremely dangerous visitor in the United States, because in Europe, where it is associated with *Diprion pini* L., the two are responsible for an immense amount of damage. *D. pini* has usually been considered the chief cause of this injury, but the two species are so closely allied [14] and so frequently confused that the presence of *D. simile* in this country must be regarded with apprehension. In Europe *D. pini* [15] is accredited with serious damage to pine in southwestern Russia, in 1914 defoliating many acres of pine in the districts of Achtyr and Izium; in Germany, in Prussia, and particularly in Brandenburg and Silesia, in

[11] Britton, W. E., and Zappe, M. P. *Op. cit.*, p. 275.
[12] From a letter from Harry B. Weiss, dated Aug. 12, 1916.
[13] Localities for specimens determined by S. A. Rohwer.
[14] *Diprion simile* Hartig has been considered a synonym of *D. pini* L.
[15] Britton, W. E., and Zappe, M. P. *Op. cit.*, p. 276.

1914; in France, in 1906; in Sweden; in Norway, in 1914, when the larvæ nearly defoliated 10-year old pines on one plantation; and in England, where they are said to injure Scotch fir as well as pine. In many of these infestations *D. simile* doubtless took a prominent part and in some instances may have been the chief depredator.

Should *D. simile* become permanently established in this country, it will be capable of great destruction. At present it is probably confined to nurseries and estates, where it is doing sufficient damage to attract considerable attention, and nurserymen and gardeners are endeavoring to exterminate it.

CONTROL.

In the United States the seeming preference of *Diprion simile* for young trees makes this sawfly primarily a nursery pest and a nursery problem rather than a forest problem. This confinement to trees in nurseries and on estates is of considerable advantage in an attempt to eradicate or control the species, since in such situations the best opportunities for combating it are found. The infestation is more easily observed early in its course, and methods of control can be employed which, despite their effectiveness, could hardly be recommended to check a forest invasion, owing to the inaccessibility and vastness of the area. Because infestations of the sawfly are at present limited to young trees in nurseries and under similar conditions, it is doubly important to combat it now, first, to check its ravages, and, second, in the hope of exterminating it or at least preventing it from ever becoming established in our forests.

In the effort to control the species its life-history and seasonal-history advantages, already referred to, should be taken into consideration and strict watch maintained against its appearance or reappearance.

Infested trees should be sprayed with some stomach poison, such as a mixture of lead arsenate and water in the proportion of 2 pounds of powdered arsenate of lead to 50 gallons of water, or, in smaller quantities, 6 teaspoonfuls of the powder to 1 gallon of water. A knapsack, barrel, or tank spraying outfit, whichever is available and convenient to use, should give good results.

Hand picking and dropping or shaking the larvæ into pails partially filled with kerosene, crushing them with the hands protected by leather gloves, and knocking or jarring them from the trees and treading on them, are all possible methods of control, especially where labor can be obtained cheaply. Such methods as these have been used successfully in Europe.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

November 12, 1923.

Secretary of Agriculture..... HENRY C. WALLACE.
Assistant Secretary..... HOWARD M. GORE.
Director of Scientific Work..... E. D. BALL.
Director of Regulatory Work..... WALTER G. CAMPBELL.
Director of Extension Work..... C. W. WARBURTON.
Weather Bureau..... CHARLES F. MARVIN, *Chief.*
Bureau of Agricultural Economics..... HENRY C. TAYLOR, *Chief.*
Bureau of Animal Industry..... JOHN R. MOHLER, *Chief.*
Bureau of Plant Industry..... WILLIAM A. TAYLOR, *Chief.*
Forest Service..... W. B. GREELEY, *Chief.*
Bureau of Chemistry..... C. A. BROWNE, *Chief.*
Bureau of Soils..... MILTON WHITNEY, *Chief.*
Bureau of Entomology..... L. O. HOWARD, *Chief.*
Bureau of Biological Survey..... E. W. NELSON, *Chief.*
Bureau of Public Roads..... THOMAS H. MACDONALD, *Chief.*
Bureau of Home Economics..... LOUISE STANLEY, *Chief.*
Fixed Nitrogen Research Laboratory..... F. G. COTTRELL, *Director.*
Division of Accounts and Disbursements..... A. ZAPPONE, *Chief.*
Library..... CLARIBEL R. BARNETT, *Librarian.*
Federal Horticultural Board..... C. L. MARLATT, *Chairman.*
Insecticide and Fungicide Board..... J. K. HAYWOOD, *Chairman.*
Packers and Stockyards Administration..... } CHESTER MORRILL, *Assistant to the*
Grain Future Trading Act Administration..... } *Secretary.*
Office of the Solicitor..... R. W. WILLIAMS, *Solicitor.*

This bulletin is a contribution from

Bureau of Entomology..... L. O. HOWARD, *Chief.*
Forest Insect Investigations..... F. C. CRAIGHEAD, *Entomologist in Charge.*

22

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
5 CENTS PER COPY

PURCHASER AGREES NOT TO RESELL OR DISTRIBUTE THIS COPY FOR PROFIT.—PUB. RES. 57, APPROVED MAY 11, 1922

▽